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Newton on Action at a Distance

STEFFEN DUCHEYNE*

Reasoning without experience is very slippery. A man may puzzle me by arguents [sic] . . . but I'll beleive my ~~ey~~ experience ↓ my eyes. ↓ (CUL Add. Ms. 3970, 619')

I. INTRODUCTION¹

ERNAN MCMULLIN ONCE REMARKED that, although the “avowedly tentative form” of the Queries “marks them off from the rest of Newton’s published work,” they are “the most significant source, perhaps, for the most general categories of matter and action that informed his research.”² The Queries (or *Quaestiones*), which Newton inserted at the very end of the third book of the *Opticks*³ or its Latin rendition, *Optice*,⁴ constitute that part of his optical *magnum opus* which he reworked and augmented the most—especially between 1704 and 1717. While the main text of the *Opticks* itself underwent only minor changes and even fewer additions,⁵ the

¹I am indebted to the audience of the conference The Reception of Newton, which took place at Ghent University from March 12–15, 2012, for encouraging and useful feedback on the presentation out of which this essay grew. I am very thankful to Eric Schliesser, Marius Stan, Steven Nadler, and the referees for the *JHP* for providing highly useful comments. I have studied the draft material of the Queries (CUL Add. Ms. 3970) and the so-called “Classical Scholia” (Royal Society, Gregory Ms. 247) during 2008 and 2009 and I am indebted to the Provosts and Syndics of Cambridge University Library and to the Royal Society, respectively, for permission to quote from the material in their care. Once the transcriptions of the draft material of the Queries became freely available online on The Newton Project web page, I have compared my own transcriptions to those to be found on <http://www.newtonproject.sussex.ac.uk/view/texts/diplomatic/NATP0005>. There are minute differences, of which the reader should be aware, between my own transcriptions and those provided on The Newton Project (<http://www.newtonproject.sussex.ac.uk>). In my own transcriptions, I have not distinguished between additions above the line and pieces of text that have been overwritten by new ones: both sorts of alterations are indicated with arrows pointing downwards. However, these minute differences do not affect the claims made in this paper. Words that are struck through in my transcriptions refer to words that were crossed out by Newton in the original text.

²McMullin, *Newton on Matter and Activity*, 3.

³First edition: 1704; second edition: 1717 (reissued in 1718); third edition: 1721; fourth edition: 1730.

⁴First edition: 1706; second edition: 1719.

⁵These changes and additions are listed in Ducheyne, “*The main Business of Natural Philosophy*,” 180–81n10.

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contrary holds for the Queries. Whereas the Queries in the first edition of the *Opticks* (1704) contained 16 rather short queries or a modest 6 pages of text,⁶ its third edition (1721), of which the text was left untouched in the posthumously published edition (1730), contained 31 oftentimes elaborate queries or no less than 70 pages of text.⁷ Such significant proliferation of words surely merits our attention. The purpose of these queries, which Newton inserted after having pointed out that he had “not finished this part of my Design [i.e. the third book of the *Opticks*, which addressed diffraction, or as Newton called it: ‘inflexion’],” was to stimulate “a further search to be made by others.”⁸ In manuscript material composed later, he commented as follows on the purpose of the Queries: “~~these things I only hint as Quæres without asserting any thing.~~”⁹ Accordingly, the queries that he introduced were only “hints to be examined & improved by the further experiments & observations of such as are ~~curious~~ ↓ inquisitive ↓.”¹⁰ In Queries 1 to 5 in the first edition of the *Opticks*, he raised a number of questions that were related to diffraction. In the remainder of the Queries, he launched questions that were related to other domains: Queries 6–11 were related to heat and fire, Queries 12, 15, and 16 to visual perception, and Queries 13 and 14 to the analogy between sound and color. Two years later, in *Optice* (1706), which was translated by Samuel Clarke, Newton added 7 additional *quaestiones*:¹¹ *Quaestiones* 17 and 18 dealt with the double refraction of “Island Crystal,” *Quaestiones* 19–22 hinted at the plausibility of a corpuscular account of light, and the long concluding *Quaestio* 23, that is, the precursor of what would become Query 31 in the final edition of the *Opticks*, addressed the “virtues, powers, or forces [*virtutes, potentias, sive vires*]” by which the particles of bodies act upon one another at a distance (in Latin: *per interjectum aliquod intervallum*).¹² In *Quaestio* 20, he made public his views on the gravitational ether for the first time.¹³ At the same time, he added some theological excerpts in which he argued that natural philosophy will lead to “the primary Cause [i.e. God] itself [*ad ipsam . . . Causam primam*]” and that it will teach us to worship of “our true and most generous Author [*verus noster & beneficentissimus Author*].”¹⁴

⁶Newton, *Opticks*¹, 132–37. After the first book, which ends at page 144, the remainder of the first edition of the *Opticks* is repaginated anew. Here I have followed the original repagination.

⁷Newton, *Opticks*³, 313–82. On queries as a genre within Newton’s natural philosophy, see Anstey, “Methodological Origins.”

⁸Newton, *Opticks*³, 132. On Newton’s study of diffraction and the problems surrounding it, see e.g. Shapiro, “Skating on the Edge.”

⁹CUL Add. Ms. 3970, 235^v [drafts prepared for *Opticks* (1717)].

¹⁰CUL Add. Ms. 3970, 242^r [drafts prepared for *Opticks* (1717)].

¹¹Newton, *Optice*¹, 299–348.

¹²Newton, *Optice*¹, 322.

¹³Newton, *Optice*¹, 309–14. Useful information on Newton’s gravitational ether is to be found in Guerlac, “Newton’s Optical Aether” and Rosenfeld, “Newton’s Views on Aether and Gravitation.” The former is still relevant for getting a grasp on the history of the Queries; the latter is still highly useful for its technical characterizations of Newton’s ethers (Rosenfeld, “Newton’s Views on Aether and Gravitation,” esp. 30, 31–32, 35). On Newton’s ethers, see, furthermore, Dobbs, *The Janus Faces of Genius*.

¹⁴Newton, *Optice*¹, 314 [*Quaestio* 20, i.e. the precursor of Query 28 in the final edition] and 348 [*Quaestio* 23, i.e. the precursor of Query 31 in the final edition]. In an intended, but never published, preface to the first edition of the *Opticks*, Newton had included a short theological paragraph (McGuire, “Principles of Philosophy,” 183; CUL Add. Ms. 3970, 479^r).

Now, at this point, the Queries or *Quaestiones* began to serve a dual purpose: on the one hand, they continued to put, in the spirit of the Queries of the first edition of the *Opticks*, certain topics on the agenda of future experimental-philosophical investigation; at the same time, however, they served the theological agenda which he cherished and gradually sought to make public after the appearance of the first edition of the *Opticks*. In the 1717 edition of the *Opticks*, which was reissued a year later, he inserted eight extra queries between what had been *Quaestiones* 16 and 17 in *Optice* (1706),¹⁵ and, additionally, he extended Queries 8, 11, 16, and 31.¹⁶ Queries 17–24 in *Opticks* (1717–18) discussed different sorts of ethers (the optical ether, the gravitational ether, and the ether potentially involved in acts of perception or volition).¹⁷ Later editions of the *Opticks* (1721; 1730) and *Optice* (1719) contained only minor changes, which do not at all affect the thesis that I seek to defend: namely, that from the 1706 edition of *Optice* and onward the Queries or *Quaestiones* served not only Newton's endeavor to stimulate future inquiry, but that, at the same time, the Queries or *Quaestiones* began to serve his theological agenda as well.¹⁸

In this paper my aim is not to dwell on all changes in the successive editions of the Queries (or *Quaestiones*). Rather, my aim is to account for certain, not very well-understood and appreciated fragments in the Queries/ *Quaestiones* of the *Opticks*/ *Optice* and to call attention to their corresponding draft material, which, as we will see, shed light on Newton's much debated views on action at a distance. On the basis of these sources, I put his views on action at a distance in a new perspective and provide them with what I believe to be an adequate account. Secondly, I argue that the simultaneous introduction of the ether speculations and the theological sections was not at all incidental, but that, from Newton's perspective, both were in fact closely interconnected. Moreover, I explain that with the words '*[a]nd to shew that I do not take Gravity for an essential Property of Bodies, I have added one Question concerning its Cause, chusing to propose it by way of a Question, because I am not yet satisfied about it for want of Experiments*' he implicitly hinted at this connection in the advertisement to the 1717 edition of the *Opticks*.¹⁹

Let me provide an overview of this paper. In the second section, I briefly take stock of the current scholarly proposals regarding Newton's views on action at a distance. In the third and most important section, I argue for an interpretative alternative that is, as I attempt to argue, explanatorily superior to past and currently

¹⁵Newton, *Opticks*, 322–28.

¹⁶Newton, *Opticks*, 314–16 [Query 8], 318–19 [Query 11], 322 [Query 16], and 365–69, 375, 377, and 379 [Query 31].

¹⁷Newton, *Opticks*, 322–28.

¹⁸Here I should call the reader's attention to Snobelen's detailed work on the theological dimensions of the Queries to the *Opticks* (Snobelen, "La luz de la Naturaleza"). Snobelen is preparing an English rendition of this paper, currently entitled "The Light of Nature," which he has so kindly allowed me to consult. Since I am concerned only with Newton's theology insofar as it is relevant to his views on action at a distance, I will refrain here from treating the theological contents of the Queries in their own right. Additionally, McGuire's and Dobbs's writings provide excellent guidance in contextualizing the theological dimensions of the Queries (McGuire, "Invisible Realm" and Dobbs, *The Janus Faces of Genius*, 207–9, 220–30).

¹⁹Newton, *Opticks*, cxxiii; italics in original.

available proposals. I shall reflect on the broader implications of my claims in the fourth section.

2. TAKING STOCK OF THE CURRENT PROPOSALS

Providing an adequate account of Newton's views on action at a distance has turned out to be a longstanding issue in Newton scholarship. Recently, action at a distance became the subject of renewed historical and philosophical reflection in a series of publications by John Henry,²⁰ Andrew Janiak,²¹ Hylarie Kochiras,²² Eric Schliesser,²³ and myself.²⁴ The discussion centers around three interrelated issues: (i) the interpretation and context of Newton's 1692/93 letter to Bentley, (ii) the significance of the "active principles" vis-à-vis the passivity of matter, and (iii) Newton's views on action at a distance in the *Queries*. Each of the above scholars has each in their own way contributed to progress on the issue at stake. However, no consensus has emerged. In this paper, I offer some arguments in favor of an alternative reading that I shall spell out and defend in the third section of this essay. Before I do so, I provide an overview of the proposals that have been put on the table thus far. Since my primary aim in this section is only to chart the accounts that are currently available and to present them in a succinct way, I shall not be criticizing them in this section. I will do so in section 3, in which I also argue for my own proposal.

Janiak argues that Newton rejected robust action at a distance in his famous letter to Richard Bentley on 25 February 1692/93, because he "held the familiar view that a substance cannot act where it is not" and because he "considered any non-local action to be simply 'inconceivable.'"²⁵ To be clear from the outset, *robust* action at a distance occurs when spatially separated bodies impress a force on one another, that is, when they, according to the definition of *vis impressa* in the *Principia*, change one another's inertial state without an intervening material or immaterial substance between them.²⁶ As I will argue, Newton rejected an intervening material substance while endorsing an immaterial one. According to Janiak, Newton's denial that "gravity could be essential to matter does not itself foreclose the possibility that material bodies might exhibit distant action." Rather, he connected his denial of action at a distance with God's "potential role as a medium for all gravitational interaction"—only then, Janiak urges, "can we decisively rule out the notion that bodies can exhibit action at a distance."²⁷ As Janiak explains the matter,

²⁰Henry, "Pray do not ascribe that notion to me"; Henry, "Isaac Newton y el Problema"; and Henry, "Gravity and *De gravitatione*."

²¹Janiak, *Newton as Philosopher*.

²²Kochiras, "Gravity and Newton's Substance Counting Problem"; and Kochiras, "Gravity's Cause and Substance Counting."

²³Schliesser, "Newton's Substance Monism."

²⁴Ducheyne, "The main Business of Natural Philosophy," 37–45; and Ducheyne, "Newton on Action at a Distance."

²⁵Janiak, *Newton as Philosopher*, 35 and 77, respectively; cf. 39–40.

²⁶For Newton's definition of impressed force, see Newton, *The Principia*, 405.

²⁷Janiak, *Newton as Philosopher*, 35 and 40.

Since God is not distant from any object at any time, and since Newton obviously thinks that God might be the very “immaterial medium” underlying all gravitational interactions among material bodies, it seems clear that when Newton contemplates the idea that God might be the relevant mediating element he is not contemplating the idea that bodies act at a distance on one another. Instead, God acts locally and *directly* on any object at any time.²⁸

Kochiras has correctly argued that Janiak’s explanation for Newton’s rejection of action at a distance in terms of God’s ubiquity is problematic because it fails to accommodate Newton’s insistence on secondary causation when it comes to the cause of gravity.²⁹ Although she essentially agrees with Janiak’s reading of Newton’s 1692/93 letter to Bentley,³⁰ Kochiras considers Janiak’s position too strong. Kochiras argues instead that Newton was *inclined* to reject robust action at a distance because he appeared to endorse the metaphysical principle that “matter cannot act where it is not.”³¹ When he speculated on the cause of gravity, he tended—in line with his belief that all causation is local—to give priority to the hypothesis of an immaterial medium.³² Although in Query 31 he appears to rely on robust action at a distance, “he soon undercuts that appearance, by denying knowledge of how those forces operate and noting that the attractions might be performed by impulse, or by some other, unfamiliar means.”³³ Instead, he “expects something to mediate between the bodies and to mediate spatially,” instead of “attributing attractive powers directly to material bodies.”³⁴ However, at the same time, Kochiras urges that “[w]hile Newton was clearly drawn to a belief in local causation, I see the aether of Query 21 [which is composed of minute particles with strong inter-particulate repulsive forces between them] as an indication that he considered abandoning it.”³⁵ According to Kochiras, the

²⁸Janiak, *Newton as Philosopher*, 39; my italics.

²⁹Kochiras, “Gravity and Newton’s Substance Counting Problem,” 270[b]–72[a]. I agree with this particular criticism of Janiak’s position, and I shall return to it. As I will explain, Newton conceived of the active principles in the Queries to the *Opticks* as secondary causes, i.e. as God’s agents (*pace* Janiak and Hesse, *Forces and Fields*, 152).

³⁰Kochiras, “Gravity and Newton’s Substance Counting Problem,” 268[a]; and Kochiras, “Gravity’s Cause and Substance Counting,” 178[a]–80[a].

³¹Kochiras, “Gravity and Newton’s Substance Counting Problem,” 275[a].

³²Kochiras emphasizes that although Newton’s attitude toward the above principle was “one of inclination rather than commitment,” this inclination nevertheless has its effect: “It pulls Newton away from the hypothesis that matter is able to act robustly and distantly, without any medium” (“Gravity’s Cause and Substance Counting,” 169[a]). Although Newton’s beliefs in the passivity of matter and local causation motivated him to search for an immaterial medium, he did not, however, consistently pin his hopes on that possibility (169n22). Kochiras, furthermore, argues that the hypothesis of an immaterial medium is problematic since it is impossible for Newton to establish it by the empirical means which he relied on in the demonstrative part of his experimental philosophy (“Gravity and Newton’s Substance Counting Problem,” 278[a]).

³³Kochiras, “Gravity’s Cause and Substance Counting,” 181[a].

³⁴Kochiras, “Gravity and Newton’s Substance Counting Problem,” 275[a].

³⁵Kochiras, “Gravity and Newton’s Substance Counting Problem,” 275n50; and Kochiras, “Gravity’s Cause and Substance Counting,” 173[a]. Kochiras reconstructs Newton’s reasoning here as follows: “Once contact action by a dense material medium has been ruled out as inconsistent with observations, and once the obstacles to grounding any immaterial medium empirically are considered, *unmediated distant action by matter looks like the best bet*” (“Gravity’s Cause and Substance Counting,” 175[a]; my italics).

ether of Query 21 involves “unmediated distant action by matter.”³⁶ In Kochiras’s view, in the *Queries* to the *Opticks* he explored two radically different gravitational hypotheses: while Query 21 posits robust action at a distance, Query 31 involves an immaterial medium, which physically underpins “the attractive and repulsive forces operating between spatially separated material bodies.”³⁷ Ultimately, in his speculative moments he wavered between accepting and rejecting robust action at a distance. She also argues, in contrast to Henry (see below), that “Newton is objecting not only to the notion that gravity is essential to matter, but also to the notion of unmediated distant action.”³⁸

Building on his earlier work,³⁹ Henry has recently argued that “*action at a distance wasn’t inconceivable for Newton (because he believed that nothing could stop an omnipotent God from bringing it about), and nowhere did he ever say it was.*”⁴⁰ Correspondingly, Newton’s letter to Bentley “does not say that action at a distance is inconceivable, much less that it is impossible. What Newton is trying to do is to make sure that what he considers to be the observed reality of action at a distance can be used to prove the existence of God (natural proofs of the existence of God are, after all, the main theme of the correspondence).”⁴¹ Therefore his primary goal in the aforementioned letter to Bentley was to not to reject robust action at a distance but rather to reject Epicurean attraction, according to which matter can by its own nature affect other pieces of matter without an intermediary.⁴² According to Henry, the content of Newton’s *Queries*, in which Newton frequently discussed actions at a distance, indicate that he actually endorsed the possibility of robust action at a distance.⁴³ Building further on the work of Henry and McMullin,⁴⁴ I have previously argued that although Newton rejected action at a distance at the gravitational level, he accepted the possibility of action at a distance on the micro-level, that is, the level of optical interactions and at the level of his speculations

³⁶Kochiras, “Gravity’s Cause and Substance Counting,” 173[a].

³⁷Kochiras, “Gravity and Newton’s Substance Counting Problem,” 277[b].

³⁸Kochiras, “Gravity’s Cause and Substance Counting,” 180[a].

³⁹Henry, “Pray do not ascribe that notion to me”; and Henry, “Isaac Newton y el Problema.”

⁴⁰Henry, “Gravity and *De gravitatione*,” 16[a]; italics in original; cf. 13[a], 14[a], and 15[b].

⁴¹Henry, “Gravity and *De gravitatione*,” 13[a].

⁴²Henry states that “what Newton is really saying to Bentley is that although they (he and Bentley) both know gravity is an action at a distance they shouldn’t allow this to be seen as an essential property of matter because to do so is to provide a hostage to atheists” (“Gravity and *De gravitatione*,” 13[a]). A similar conclusion was previously reached in Meyerson, *Identité et réalité*, 412–13.

⁴³Henry, “Gravity and *De gravitatione*,” 14[a]. Similarly, Heimann and McGuire have argued that in light of the *Queries* to the *Opticks* and especially in light of Query 21 “it is clear that action at a distance is a doctrine which never seriously troubled Newton” (“Newtonian Forces and Lockean Powers,” 242). Another option was taken by Cohen, who stated in his “Guide to Newton’s *Principia*” that according to Newton the inter-particle forces of attraction and repulsion are “sufficiently short-range in their action . . . that they do not raise a major problem of understanding their mode of action.” On this account, they do not fall into “the category of the forces acting at a distance” (Newton, *The Principia*, 61).

⁴⁴McMullin argued that the *Queries* to the *Opticks* indicate that Newton had no objections to action at a distance *per se* (McMullin, *Newton on Matter and Activity*, 144n137 and 151n210). He offered the following potential explanation for the occurrence of action at a distance in the *Queries*: “he [i.e. Newton] could allow *intrinsic* activity to the aether more easily than he could to ordinary matter” (99).

on the cause of gravity.⁴⁵ I have now found good reasons to abandon my earlier take on the matter and I shall spell out these reasons.

Schliesser, finally, has argued for a totally different interpretation. According to him, it is possible that “[i]f attractive agents can be material then for Newton matter need not always be passive.”⁴⁶ Schliesser maintains that one can deny that matter has a principle of self-motion, which Newton, according to him, denied in his famous 1692/93 letter to Bentley, and still allow that matter can be active.⁴⁷ Correspondingly, Schliesser points out that Query 31 allows “as he [i.e. Newton] explicitly says in his [fourth] letter to Bentley, that the attractive ‘agent be material.’”⁴⁸ Following this line of reasoning, Schliesser claims that Newton’s account in *A Treatise of the System of the World/De mundi systemate* entails that robust “action at a distance really takes place in nature.”⁴⁹

These are, in a nutshell, the accounts that have been put on the table. In the next section, I shall argue, while drawing heavily on the draft versions of the Queries, that contrary to Henry’s claims on the Queries, Kochiras’s claims on Query 21, and Schliesser’s claims on *De mundi systemate*, Newton never accepted robust action at a distance, and that all four of the above proposals have failed to take into account the relevant theological background, which informed and motivated his views on action at a distance. Newton used the term ‘action at a distance’ to refer to motion that is not produced “mechanically,” that is, by the direct contact between parts of matter. He conceived of two ways in which motion could be brought about non-mechanically: either the motion occurs without intervening substance or it occurs through the intervention of an immaterial substance. I shall argue that by distinguishing between (i) “robust action at a distance,” which, as explained above, I take to refer to the view according to which spatially separated bodies impress a force on one another without an intervening material or immaterial substance between them, and (ii) “non-mechanically mediated action at a distance,” which I take to refer to view according to which the “attractions” (or “repulsions”) between material bodies are produced by and mediated through a non-mechanical active principle⁵⁰—whatever that agent might ultimately be and however it might

⁴⁵Ducheyne, “The main Business of Natural Philosophy,” 44–45. Although he did not address this issue in detail, Wilson seems to agree with this stance: “When Newton in the second English edition of his *Opticks* (1717) tentatively proposed an aethereal cause for gravity, his intent was not to avoid action-at-a-distance, but to show that he did not ‘take Gravity to be an essential Property of Bodies’; the particles of his aether mutually repelled one another” (“Euler on Action-at-a-Distance,” 400).

⁴⁶Schliesser, “Newton’s Substance Monism,” 163 [b].

⁴⁷Schliesser, “Newton’s Substance Monism,” 163 [b]–64 [a].

⁴⁸Schliesser, “Newton’s Substance Monism,” 163 [b].

⁴⁹Schliesser, “Without God,” 85.

⁵⁰Throughout this essay I rely on Newton’s own understanding of gravity’s cause being non-mechanical, according to which gravity is not produced by the direct contact between pieces of matter, but by “some other Cause than dense Matter” (Newton, *Opticks*⁴, 369). In the General Scholium (1713), Newton listed the desiderata that the cause of gravity, whatever it might be, should be meet: “Indeed, this force [of gravity] arises from some cause that *penetrates as far as the centers of the sun and planets without diminution of its power to act*, and that *acts not in proportion to the quantity of the surfaces of the particles on which it acts* (as mechanical causes are wont to do) *but in proportion to the quantity of solid matter*, and *whose action is extended everywhere to immense distances*, always decreasing as the squares of the distances” (Newton, *The Principia*, 943; my italics). Newton was convinced that a dense material fluid that acts by direct contact could not meet these three desiderata.

ultimately operate upon matter—we can account for the *prima facie* conflicting fragments in Newton's writings, and, additionally, for the conflicting views on his views on action at a distance in the current literature. My claim is not that Newton himself explicitly signaled the above distinction to his readers; rather, my claim is that, if we study Newton's usage of 'action at a distance' in different contexts, we find that he is using 'action at a distance' in two distinct senses, which are captured adequately by the distinction I have introduced above. More precisely, I shall first argue that in his fourth letter to Bentley Newton was rejecting robust action at a distance. Afterwards, I highlight that Newton in the *Queries to the Opticks* systematically used the phrase 'action at a distance' to refer to non-mechanically mediated action at a distance. Although as we will see Newton identified a non-mechanical ether as the cause of gravity in the *Queries to the Opticks*, he never explained how it operates upon matter.

3. NEWTON'S VIEWS ON ACTION AT A DISTANCE

In the following subsections, I address the three issues that I have put on the agenda at the outset of the second section. Correspondingly, in 3.1, I shall contextualize Newton's 1692/93 letter to Bentley; in 3.2, I shall address the significance of Newton's "active principles" vis-à-vis the passivity of matter; and, finally, in 3.3, I shall explicate Newton's views on action at a distance in the *Queries*.

3.1. "... as it must if gravitation in the sense of Epicurus"

One of the *loci classici* for the scholarly debate on Newton's views on action at a distance is his letter to Richard Bentley on 25 February 1692/93. Elsewhere I have argued in considerable detail for my own interpretation of this important letter.⁵¹ Here I will repeat the gist of my interpretation, but, at the same time, I will strengthen it. In his famous fourth letter to Bentley, Newton wrote the following:

Tis inconceivable, that inanimate brute Matter, should (without ye mediation of something else wch is not material), operate upon & affect other matter without mutual contact; as it must if gravitation in the sense of Epicurus, be essential & inherent in it. And this is one reason why I desired you not to ascribe innate gravity to me. That gravity should be innate

In Query 28 Newton explained that, on account of having *vis inertiae*, a mechanical ether—however small its particles may be—would offer notable resistance to the motions of the celestial bodies and he pointed out that, in view of the regular and unperturbed motions which the celestial bodies actually describe, it is manifest "that the Heavens are void of all sensible Resistance, and by consequence of all sensible Matter" (Newton, *Opticks*⁴, 365). Correspondingly, Newton rejected attempts to feign "[h]ypotheses for explaining all things mechanically [i.e. hypotheses based on direct contact]" and concluded that "[a] *dense Fluid* can be of no use for explaining the Phænomena of Nature, the Motions of the Planets and Comets being better explain'd without it. It serves only to disturb and retard the Motions of those great Bodies, and make the Frame of Nature languish: And as it is of no use, and hinders the Operations of Nature, and makes her languish, so there is no evidence for its Existence, and therefore it *ought to be rejected*" (Newton, *Opticks*⁴, 368–69; my italics). Given the above context it is clear that in Newton's view a mechanical ether is a material one, which acts by direct contact, and that a non-mechanical ether is an immaterial one. Correspondingly, when I use the terms 'mechanical' or 'non-mechanical' throughout this essay, I consistently refer to the meaning which Newton himself attributed to them.

⁵¹Ducheyne, "The main Business of Natural Philosophy," 42–44.

inherent & essential to matter so yt one body may act upon another at a distance through a vacuum wthout the mediation of any thing else & by & through wch their action and force may be conveyed from one to another is to me such an absurdity that I beleive no man who has in philosophical matters any competent faculty of thinking can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws, but *whether this agent be material or immaterial is a question I left to ye consideration of my readers.*⁵²

From the above quotation, it is clear, at least *prima facie*, that Newton introduced two important terms: that of ‘mediation,’ at the very start of the above quotation, and that of ‘agency,’ at the end of the quotation. One might be tempted to conclude that Newton was discussing one and the same thing, so that the first occurrence of ‘mediation’ and ‘agency’ denote the same thing. Accordingly, Kochiras has concluded that “Newton states his own view in the first sentence [namely, his inclination toward the view that the agent, i.e. the secondary cause, producing gravity is immaterial⁵³], while in the last he describes what he did in the *Principia*, which was to refrain from stating his own view [regarding the secondary cause producing gravity],”⁵⁴ and that Newton was “not using the [first occurrence of the] term ‘mediation’ to denote God or divine action,”⁵⁵ but referring to his “inclination to the principle of local causation.”⁵⁶ There is, however, contextual evidence suggesting that with the first occurrence of ‘mediation,’ Newton was referring to divine providence and that with ‘agency’ he was referring to the secondary cause of gravitation. The sentence immediately preceding the quotation from Newton’s fourth letter to Bentley states, “The last clause of your second Position I like very well.”⁵⁷ The clause from Bentley’s letter on 18 February to which Newton referred to goes as follows: “[Sir, I make account, yt your courteous suggestion by your Last, yt a Chaos is inconsistent with ye Hypothesis of innate Gravity, is included in this paragraph of mine.] and again, tis inconceivable, yt inanimate brute matter should (*without a divine impression*) operate upon & affect other matter without mutual contact: as it must be, if gravitation be essential and inherent in it.”⁵⁸ Kochiras insists, however, that

[i]f Newton meant to refer to God or God’s action then, an easier and far clearer way of doing so would be to use one of those phrases or better yet, simply to retain Bentley’s quite precise phrase, “divine impression.” Instead, he replaces Bentley’s clear and precise phrase with one that appears nowhere else in the correspondence: “ye mediation of something else wch is not material.” This phrase is imprecise, since there are things other than God which are not material—minds, for instance, and perhaps also some immaterial aether.⁵⁹

However, in view of Newton’s statement, which immediately precedes the quotation from the fourth letter to Bentley and which Kochiras does not signal

⁵²Newton, *Correspondence*, III.253–54; italics and underscores added.

⁵³Kochiras, “Gravity’s Cause and Substance Counting,” 181n109.

⁵⁴Kochiras, “Gravity and Newton’s Substance Counting Problem,” 268n5.

⁵⁵Kochiras, “Gravity’s Cause and Substance Counting,” 180[a].

⁵⁶Kochiras, “Gravity’s Cause and Substance Counting,” 181[a].

⁵⁷Newton, *Correspondence*, III.253.

⁵⁸Newton, *Correspondence*, III.249.

⁵⁹Kochiras, “Gravity’s Cause and Substance Counting,” 180[b].

to her readers, that “ye growth of new systems out of old ones *without ye mediation of a divine power* seems to me apparently absurd,”⁶⁰ Kochiras’s claim is rather unconvincing. Instead, it seems more likely that “ye mediation of something else wch is not material” simply refers to “ye mediation of a divine power.” Divine providence was one of the focal points of the Newton-Bentley correspondence, and it should not be a surprise that it crops up in the fourth letter to Bentley.⁶¹ In his first letter to Bentley (10 December 1692), for instance, Newton pointed out that the regular motion of the planets is “the effect of Counsel.”⁶² Similarly, in his second letter to Bentley (17 January 1692/93), he emphasized that “gravity may put ye planets into motion but without ye divine power it could never put them into such a Circulating motion as they have about ye Sun.”⁶³ However, the reference to God’s mediation does not imply that Newton conceived of God as the direct cause of gravity. From his statement “but whether this agent be material or immaterial is a question I left to ye consideration of my readers” it is clear he thought that gravity requires a secondary cause or agent, for he would surely not ascribe the predicate ‘material’ to God.⁶⁴ Newton endorsed the view according to which God made and governs the world “by his Agents”—thereby implying that God’s agents act as secondary causes.⁶⁵

There are additional problems for Kochiras’s interpretation: her claim that “Newton states his own view in the first sentence, while in the last he describes what he did in the *Principia*, which was to refrain from stating his own view” implies that Newton would have been inclined toward a non-mechanical cause of gravitation by 25 February 1692/93. However, as I have argued elsewhere, this seems rather unlikely, for Newton came to entertain a non-mechanical account of gravitation as the most likely candidate for explaining gravity only by May 1694, that is, by the time he showed his so-called “Classical Scholia” to David Gregory.⁶⁶ By May 1694, Newton came to emphasize that spatially separated bodies do not gravitationally attract one another unless some moving active principle intercedes—note that in Newton’s thought ‘active principles’ always referred to non-mechanical secondary causes.⁶⁷ By that time he came to reject the only mechanical explanation of gravity that he had, shortly after the publication of the first edition of the *Principia*, considered as a plausible candidate to explain gravity: the mechanical ether that Fatio De Duillier introduced in 1690 and which consisted of ether particles in swift random motion that are so small that the mutual collisions of these particles could

⁶⁰Newton, *Correspondence*, III.253; my italics.

⁶¹The opening sentence of Newton’s first letter to Bentley reads, “When I wrote my treatise about our Systeme I had an eye upon such Principles as might work with considering men for the beleife of a Deity & nothing can rejoice me more then to find it usefull for that purpose” (Newton, *Correspondence*, III, 233).

⁶²Newton, *Correspondence*, III.235.

⁶³Newton, *Correspondence*, III.240.

⁶⁴Cf. Henry, “Gravity and *De gravitatione*,” 13[b].

⁶⁵CUL Add. Ms. 3965, 368^v [post-1713]. In Ducheyne, “*The main Business of Natural Philosophy*,” 41–42, I argue that there is no clear-cut evidence in the Classical Scholia or in later documents that suggests that Newton thought of God as being the *direct* cause of gravity.

⁶⁶Ducheyne, “*The main Business of Natural Philosophy*,” 38–43.

⁶⁷CUL Add. Ms. 3965, 269^r [ca. 1694].

be ignored.⁶⁸ In other words, at the time of the composition of the fourth letter to Bentley Newton still left open the possibility that gravity could be explained by some sort of material secondary cause. In manuscript material composed before the fourth letter to Bentley, Newton noted that De Duillier's hypothesis is the only one "by which gravity may be explained mechanically [*per quam gravitas explicetur mechanice*]." ⁶⁹ Only later, that is, in the General Scholium and in the *Queries* to the *Opticks*, would Newton openly deny that gravity can be explained mechanically.

Consequently, it seems that, while the first occurrence of 'mediation' in the quotation refers to his belief that an immaterial primary cause, that is, God, regulates the secondary cause of gravity, 'agency' refers to the secondary cause that is the vehicle of gravitational interaction. In the first sentence of the quotation from his fourth letter to Bentley, Newton was not, as Kochiras claims, reporting on his views on the agent or secondary cause producing gravity. In the fourth letter to Bentley, he preferred not to address this matter and restricted himself to pointing out that gravity's secondary cause, whether material or immaterial, is dependent on God's counsel.

Let us now proceed to a different matter. What was it that Newton was rejecting in his famous letter to Bentley? Yet again, there currently is no consensus on this matter. Henry states that Newton was not rejecting action at a distance, but only the claim that gravity is essential to matter.⁷⁰ According to Janiak, Newton's denial "that gravity could be essential to matter does not itself foreclose the possibility that material bodies might exhibit distant action."⁷¹ In what follows, I argue that Newton's denial that gravity is essential to matter, on the one hand, and his rejection of robust action at a distance, on the other, cannot be separated. In order to do so, I shall explicate what Newton—in the context of his of discussions of action at a distance—meant by the claim that gravity is essential to bodies.

Janiak argues that, while for Newton the claim that gravity is essential to matter entails the claim that material bodies act on one another at a distance, the converse does not hold.⁷² The claim that bodies act on one another at a distance does not entail the claim that gravity is essential to matter, for "two otherwise lonely bodies at some spatial separation from one another might act in that fashion [i.e. at a distance], but lose their property of gravity through some arbitrary increase in their spatial separation, thereby rendering the property merely accidental (Newton himself notes that gravity cannot be essential to matter because it *decreases* with an increase in spatial separation—*Principia*, 796)."⁷³ In his commentary to Rule III, to which Janiak refers, Newton stated, furthermore, that inertia is essential because it is immutable.⁷⁴ Janiak in other words is contrasting essential versus accidental qualities, in the following way: while inertia is an immutable-universal quality,

⁶⁸Rosenfeld, "Newton's Views on Aether and Gravitation," 33. See furthermore Fatio de Duillier, "*De la cause de la pesanteur*."

⁶⁹CUL Add. Ms. 4005, 28^r [ca. 1690–93].

⁷⁰Henry, "Gravity and *De gravitatione*," 12[b].

⁷¹Janiak, *Newton as Philosopher*, 35.

⁷²Janiak, *Newton as Philosopher*, 35–36n51.

⁷³Janiak, *Newton as Philosopher*, 36n51; my italics.

⁷⁴Newton, *The Principia*, 796.

that is, a universal quality that cannot be increased and diminished, gravity is an accidental-universal quality, that is, a universal quality that can be increased and diminished. It is this distinction that seems to underlie Janiak's argument: for if gravity is a universal quality that can be increased and diminished, then, in the above scenario, action at distance is compatible with gravity being an accidental quality of matter and, therefore, action at a distance does not imply the claim that gravity is essential to matter. While I agree that the above distinction provides a useful (albeit partial) explication of Rule III,⁷⁵ which Newton introduced in the second edition of the *Principia* (1713), that is, 20 years after the composition of his fourth letter to Bentley, I tend to disagree, however, that the above explication of how Newton understood the claim that gravity is essential to matter is the relevant one for understanding the fourth letter to Bentley (and the Queries). When discussing action at a distance, Newton attributed a different meaning to what it means for gravity to be essential to matter.

For Newton the claim that gravity is essential to matter is, in the context of his fourth letter to Bentley and the Queries, equivalent to the claim that bodies do not require a divinely regulated secondary cause for their motions (for further argumentation and contextualization, see 3.2).⁷⁶ If gravity is essential to bodies in this sense, then the gravitational attraction between spatially separated bodies results not from the agency of a secondary cause, but from a quality that is "inherent"⁷⁷ to matter itself. Gravity being essential to bodies implies that matter itself acts as a source of motion and activity. Note that if gravity is inherent to matter, then, since gravitational attraction does not require a secondary cause, bodies act on one another at a distance in a robust sense, and, vice versa, if bodies robustly act on one another across a vacuum, that is, without the intervention of a secondary cause, then gravity is inherent to matter. Therefore, in contrast to what Henry, Janiak, and Kochiras argue,⁷⁸ Newton's denial of Epicurean attraction cannot be separated from his rejection of robust action at a distance. Rather, given the above interpretation, by writing that it is "inconceivable, that inanimate brute Matter, should (without ye mediation of something else wch is not material), operate upon & affect other matter without mutual contact; as it must if gravitation in the sense of Epicurus, be essential & inherent in it," Newton was signaling that robust action at a distance is equivalent to the claim that gravity is essential to matter: robust

⁷⁵Ducheyne, "The main Business of Natural Philosophy," 114–18.

⁷⁶In his first letter to Bentley, Newton denied that gravity is independent from God's counsel by stressing that "[I]ts plaine that there is no natural cause wch could determine all ye Planets both primary and secondary to move ye same way & in ye same plane without any considerable variation. This must be the effect of Counsel. . . . To make this systeme therefore with all its motions, required a Cause wch understood & compared together the quantities of matter in ye several bodies of ye Sun & Planets & ye gravitating powers resulting from thence, the several distances of the primary Planets from ye Sun & secondary ones from Saturn Jupiter & ye earth, & ye velocities with wch these Planets could revolve at those distance about those quantities of matter in ye central bodies. And to compare & adjust all these things together in so great a variety of bodies argues that cause to be not blind & fortuitous, but very well skilled in Mechanicks and Geometry" (Newton, *Correspondence*, III.232–35).

⁷⁷Newton, *Correspondence*, III.240.

⁷⁸Henry, "Gravity and *De gravitatione*," 13[a]; Janiak, *Newton as Philosopher*, 35; and, Kochiras, "Gravity's Cause and Substance Counting," 173[a].

gravitational action at a distance simply *is* Epicurean attraction. In manuscript material composed in 1694, Newton pointed out that the Epicurean mode of explaining the frame of nature in terms of matter and void alone leads to atheism: "In distinguishing all of nature in either body or void space the Epicureans have entirely denied God, but this is excessively absurd. Because two planets separated from each other by a long distance do not act on each other by the force of gravity or in any other way except but by some moving active principle which intercedes between them and by which the force is transmitted from the one to the other."⁷⁹ According to Newton, the Epicureans reject God by neglecting the secondary causes through which God governs the physical world and by failing to include active principles in their basic ontology. In 3.2 I will elaborate on Newton's theological reservations against Epicurean action at a distance and strengthen the above analysis. In order to do so, I shall discuss Newton's views on the passivity of matter, but first we will review yet another account.

3.2. "... other laws of motion unknown to us"

Schliesser claims, on the basis of his interpretation of some pieces of text that are taken from Newton's posthumously published *A Treatise of the System of the World/De mundi systemate* (first published in 1728; composed ca. 1685),⁸⁰ that Newton's fourth letter to Bentley "does not rule out the existence of (properly reconceived) matter as an *active* agent or cause of gravity."⁸¹ The way to reconceive matter properly, according to Schliesser, is to think of gravity as a relational interaction force between pairs of bodies:

A way to capture this is to say that a body has two dispositions: a "passive" disposition to respond to impressed forces is codified in the second law of motion whereas an "active" disposition to produce gravitational force is treated as a distinct interaction codified in the third law of motion. Thus, we see that the "cause" of the action is "the conspiring nature of both" bodies. For the "conspiring" to occur, the bodies must *share* a "nature." . . . To sum up: the cause consists in the "nature" or "disposition" of two bodies (or a twofold cause because involving two bodies), but it is one interaction or "nature."⁸²

⁷⁹*Epicurei naturam totam in corpus et inane distinguentes Deum pernegarunt: at absurde nimis. Nam Planetæ duo ab invicem longo vacui intervallo distantes non vi gravitatis neque ullo modo agent in se invicem nisi movente principio aliquo activo quod utrumque intercedat & per quod vis ab utroque in alterum propagetur* (CUL Add. Ms. 3965, 269' [1694]; my translation).

⁸⁰For some important observations on this treatise, see Ducheyne, "The main Business of Natural Philosophy," 30n147. Readers of *A Treatise of the System of the World/De mundi systemate* should be aware that there are significant differences, which were introduced during the editing process, between the text of *De mundi systemate* and the manuscript, i.e. CUL Add. Ms. 3990, 1'-56' on which it is based, on the one hand, and between *A Treatise of the System of the World* and *De mundi systemate*, on the other. In view of this, straightforwardly inferring Newton's views from *A Treatise of the System of the World/De mundi systemate* is precarious without establishing that certain statements occur in the original manuscript as well. In general *De mundi systemate* is more reliable than *A treatise of the system of the world*, but the ultimate arbiter is of course CUL Add. Ms. 3990, 1'-56'.

⁸¹Schliesser, "Without God," 91; my underscore.

⁸²Schliesser, "Without God," 85; cf. 80 and 86. I agree that gravity was for Newton a relational interaction force (Ducheyne, "The main Business of Natural Philosophy," 30-34, 116, and 118), but I deny that it entails the activity of matter.

Thus construed, Schliesser takes it that Newton's account in *De mundi systemate* entails "a very clear description of action at a distance; applying the third law of motion is *not merely a mathematical statement, but action at a distance really takes place in nature*."⁸³

Does Schliesser's account correspond to Newton's view on the matter around 1685, and does it correspond to the views Newton developed afterward?⁸⁴ Before I address this question, I would like to make some observations on Schliesser's way of contextualizing *De mundi systemate*. Schliesser claims that "the *Treatise* is more speculatively metaphysical than the published version of Book III" and he observes that "Newton knows that it is a kind of speculative metaphysics or hypothesis that he deplores with increasing vehemence in others as he anticipates and gets embroiled in debates with the Mechanical philosophers and later the vituperative, politicized exchanges with Leibniz and his followers."⁸⁵ Let us take a look at what Newton wrote on *De mundi systemate* at the beginning of Book III of the *Principia*. He wrote,

On this subject I composed an earlier version of book 3 in popular form [*methodo populari*], so that it might be more widely read. *But those who have not sufficiently grasped the principles set down here will certainly not perceive the force of the conclusions* [*vim consequentiarum minime percipient*], nor will they lay aside the preconceptions [*præjudicia*] to which they have become accustomed over many years; and therefore, to avoid lengthy disputations [*& propterea ne res in disputationibus trahatur*], I have translated the substance of the earlier version into propositions in a mathematical style [*more mathematico*], so that they may be read only by those who have first mastered the principles [*qui principia prius evolverint*].⁸⁶

He indicated himself that *De mundi systemate* is foremost a *popular* version of Book III. In the above quotation, he explained why he had refrained from publishing this popular version. The concern that he raised is *methodological*: those who have not mastered the physico-mathematical treatment of Book I will "certainly not perceive the force of the conclusions," and *therefore* (*propterea*) in the *Principia* he decided to physically treat of the forces in the *systema mundi* only after providing his physico-mathematical treatment of centripetal forces. There is no hint at all that Newton withheld the publication of *De mundi systemate* during his lifetime because he considered it to be "speculatively metaphysical." The reason why he withheld it was because, contrary to his own methodological standards, in *De mundi systemate* the physico-mathematical treatment of force, which is vital for Newton's non-hypothetico-deductive inference of the inverse-square centripetal forces in the system of the world,⁸⁷ was not clearly as demarcated from the physical treatment of force as in the *Principia*. Both treatments in *De mundi systemate* were, in fact, blended. Schliesser could then argue that at the outset of Book III of the *Principia* Newton was clever enough not to hint at the "speculatively metaphysical" contents of *De mundi*

⁸³Schliesser, "Without God," 85; my italics.

⁸⁴Schliesser obviously claims that the answer to the first question is positive. Although he does not make any claims on Newton's later views, he does claim that the above interpretation sheds light on Newton's fourth letter to Bentley ("Whithout God," 81–83) and on Newton's *Queries* ("Newton's Substance Monism," 163 [b]). I reject both of these claims.

⁸⁵Schliesser, "Without God," 81 and 84.

⁸⁶Newton, *The Principia*, 793; my italics; Newton, *Philosophiae Naturalis*, II.549.

⁸⁷Ducheyne, "The main Business of Natural Philosophy," chapters 2 and 3.

systemate and to resort, instead, to a methodological sounding statement. In order to accept this move, however, it should *first* be shown that Newton's statements in *De mundi systemate* were indeed "speculatively metaphysical." Since there is no independent evidence that supports Schliesser's account, his account can only be adequate *if and only if* his textual interpretation of *De mundi systemate* is adequate.

Let us look at the text on which Schliesser bases his account:

For all action is mutual, and makes the bodies mutually to approach one to the other,⁸⁸ and therefore must be the same in both bodies. It is true that we may consider one body as attracting another as attracted. But this distinction is more mathematical than natural.⁸⁹ The attraction is really common of either to other, and therefore of the same kind in both.⁹⁰ . . . And though the mutual actions of two Planets may be distinguished and considered as two, by which each attracts the other; yet as those actions are intermediate, they don't make two, but one operation between two terms.⁹¹ Two bodies may be mutually attracted, each to the other, by the contraction of a cord interposed. There is a double cause of action, to wit, the disposition of both bodies, as well as a double action in so far as the action is considered as upon two bodies.⁹² But as betwixt two bodies it is but a single one. . . . By the action with which the Sun attracts Jupiter, Jupiter and the Sun endeavour to come nearer together [by the *third Law of Motion*]⁹³ and by the action, with which Jupiter attracts the Sun, likewise Jupiter and the Sun endeavour to come nearer together. But the Sun is not attracted towards Jupiter by a two-fold action, nor Jupiter by a two-fold action towards the Sun: but 'tis one single intermediate action, by which both approach nearer together. . . . In this sense it is that we are to conceive one single action to be exerted betwixt two Planets, arising from the conspiring natures of both.⁹⁴

Although the words 'arising from the conspiring natures of both' might be suggestive, should we really endorse the conclusion that, *when properly reconceived*, the "conspiring natures" of material bodies should be properly conceived of "as an *active agent or cause of gravity*" for Newton, or is it more plausible that Newton had written these words in a sense that was—in the spirit of what he himself considered

⁸⁸At this point, the translator omitted '(per Motus Legem 3.)' (Newton, *De mundi systemate*, 25; CUL Add. Ms. 3990, 14^r).

⁸⁹The original reads *Considerari potest corpus unum ut attrahens, alterum ut attractum, sed hæc distinctio magis mathematica est quàm naturalis* (CUL Add. Ms. 3990, 14^r). Although Newton granted that we may consider the mutual attraction between a pair of bodies as two-fold so that each body separately attracts the other, *physically speaking* it is to be considered as "one operation between two terms," as Newton clarified in the remainder of the quotation. Correspondingly, in this context 'natural' refers to 'physical.'

⁹⁰The original reads, *Attractio reverà est corporis utriusque in utrumque, atque adeo ejusdem generis in utroque* (CUL Add. Ms. 3990, 14^r).

⁹¹The original reads, *Et quamvis binorum Planetarum actiones in se mutuò distingui possint ab invicem ut actiones binæ quibus uterque trahit alterum considerari: tamen . . . quatenus intermediæ sunt non sunt binæ sed operatio simplex inter binos terminos* (CUL Add. Ms. 3990, 14^r).

⁹²The original reads, *Causa actionis gemina est, nimirum dispositio utriusque corporis; actio item gemina quatenus in bina corpora: at . . . quatenus inter bina corpora simplex est et unica* (CUL Add. Ms. 3990, 14^r–15^r).

⁹³The reference to Law III was added in the 1737 edition of *A Treatise of the System of the World* and was originally contained in CUL Add. Ms. 3990, 15^r.

⁹⁴Newton, *A Treatise of the System of the World*, 38–40. The last sentence in the original reads, *Ad hunc modum concipe simplicem exerceri inter binos Planetas ab utriusque conspirante naturâ oriundum operationem; & hæc eodem modo se habebit ad utrumque: adeò proportionalis existens materiæ in uno eorum, proportionalis eris materiæ in altero* (CUL Add. Ms. 3990, 15^r).

to be a popular treatment—rather loose, and without aiming at “speculatively metaphysical” conclusions? I will argue that the latter is the most likely. In the above quotation, Newton concluded that “we are to conceive one single action to be exerted betwixt two Planets, arising from the conspiring natures of both.” His main point here is that gravity is an interaction force and that mass is one of the causally salient variables in the production of gravitational effects. In the above quotation there is no hint whatsoever that he considered matter, when properly reconceived, as an active agent. Moreover, there are further problems: Schliesser’s account is incompatible with the methodological beliefs that Newton held at the time of the composition of *De mundi systemate*. Schliesser attributes to Newton the view that “applying the third law of motion is not merely a mathematical statement, but *action at a distance really takes place in nature*”—here he, yet again, imposes an interpretation that is not grounded in the text. To ascribe to Newton what I have called robust action at a distance, is to miss out on significant features of his methodology, namely his desire in *De mundi systemate* to remain neutral with respect to defining “a species or mode of action, or a physical cause or reason [*modum actionis causamve aut rationem physicam*].”⁹⁵ It is also incongruent with Newton’s theological reservations against robust action at a distance. Schliesser’s account is, more specifically, incompatible with his views on the passivity of matter. In discussing Newton’s ‘active principles’ in what follows, my purpose is not to document all extant manuscript material in detail, but instead to point to the significance of the active principles within the context of the Queries of the *Opticks*.

By 1694 Newton became convinced that, like many other natural phenomena, gravitational interaction requires the activity of certain non-mechanical active principles. The significance of Newton’s changes of mind cannot be overestimated. Before 1694 he had conceptually differentiated the gravitational ether, which he took to work mechanically, from the vegetative ethers, which he considered to be caused by active spirits.⁹⁶ Given the affinities that Newton came to see between gravitational and vegetative processes, it should not come as a surprise that both kinds of processes played a crucial role in the Queries to the *Opticks*. According to Newton, vegetative processes are indicative of the fact that, besides *vis inertiae* and the “passive laws of motion arising from them,” there are also “very potent” laws of motion in nature:

[Not ↓ w ↓ all these ↓ the above mentioned ↓⁹⁷ motions are too ↓ so ↓ great & violent to cause ↓ to be ↓ as to shew that ↓ in fermentations ↓ there is new motion in the world

⁹⁵Newton, *Mathematical Papers*, VI.97. In order to show that at a date close to the composition of CUL 3990, ff. 1^r–5⁶ (1685) Newton already subscribed to the views that he would reiterate later in the text to Definition VIII in the first edition of the *Principia* (1687) (Newton, *The Principia*, 408), I have here deliberately quoted from the initial revise of *De motu* (Winter/Early Spring 1684–85). Furthermore, there are clear indications that Newton thought that *De mundi systemate* contained no speculations or hypotheses on the cause of gravitational interaction. Newton wrote, for instance, that he wanted “to avoid all questions about the nature or quality of this force, which we would not understood to determine by any hypothesis” (Newton, *A Treatise of the System of the World*, 4; CUL Add. Ms. 3990, f. 2^r).

⁹⁶Dobbs, *The Janus Faces of Genius*, 100–103.

⁹⁷Newton was referring to processes of fermentation here.

generated from other Principles then the usual laws of motion.] Now the above mentioned motions are so great & violent as to shew that in fermentations bodies ~~↓ w^{ch} rest ↓ almost ↓ rest ↓~~ are put into ~~↓ new ↓~~ motions by a ~~much more potent principle that ↓ en ↓~~ those laws of motio the Vis in the laws of motion & the Vis inertiae of the matter [& that by this principle new motions] & ~~↓ very potent ↓ active ↓~~ Principle Principle w^{ch} is much more potent then the ~~↓~~ which acts upon bodies ~~↓ them ↓~~ only when they approach one another, [illegible word] [& w^{ch} is much more potent then are the ~~pass~~ passive laws of motion arising from the Vis inertiae of the matter.]⁹⁸

According to Newton, bodies are intrinsically passive and are moved only by active principles, that is, non-mechanical agents: “For we meet very little Motion in the World, besides what is owing to these active Principles,” as Newton declared in Query 31 of the *Opticks*.⁹⁹ “The *Vis inertiae*,” he stated, “is a passive Principle by which Bodies persist in their Motion or Rest, . . . *By this Principle alone there never could have been any Motion in the World.* Some other Principle was necessary for putting Bodies into Motion [i.e. an active principle]; and now they are in Motion, some other Principle is necessary for conserving the Motion.”¹⁰⁰ “And if it were not for these [active] Principles,” Newton wrote in corresponding manuscript material, “the bodies of the Earth, Planets, Comets, Sun, & all things in them would grow cold & freeze & become *inactive masses*, & all putrefaction generation vegetation & life would cease, & the Planets the Planets & Comets would not remain in their Orbs.”¹⁰¹ In an unpublished manuscript sheet, which was part of Newton’s preparations for the second edition of the *Principia*, Newton recorded that the most wise order of things could not have arisen “from matter alone and motion or from the nature of things [*a materia sola et motu aut a rerum Natura*].”¹⁰² Newton argued that God regulates the natural world by means of certain “active Principles,” which cause—*inter alia*—gravitation, fermentation, and cohesion.¹⁰³ Correspondingly, in an unpublished draft version of what was to become Query 31, he wrote,

Whence it seems to have been an ancient opinion that matter depends upon a Deity for its ↓ laws of ↓ motion as well as for its existence. *The Cartesians make God the author of all motion & its as reasonable to make him the author of the laws of motion. Matter is a passive principle & cannot move it self. It continues in its state of moving or resting unless disturbed. It receives motion proportional to the force impressing it. And resists as much as it is resisted. These are passive laws & to affirm that there are no other is to speak against experience.* For we find in o^r selves a power of moving our bodies by o^r thought ↓ Life & thinking ↓ will ↓ are active Principles by w^{ch} we move our bodies, & thence arise other laws of motion unknown to us ↓.¹⁰⁴

The above remarks square nicely with Newton’s denial that motion results from qualities that are inherent to matter itself and with his belief that for their motions

⁹⁸CUL Add. Ms. 3970, 244^r [drafts prepared for *Opticks* (1717)].

⁹⁹Newton, *Opticks*⁴, 399.

¹⁰⁰Newton, *Opticks*⁴, 397; my italics.

¹⁰¹CUL Add. Ms. 3970, 282^r; my italics. Cf. 621^r [drafts prepared for *Opticks* (1717)] and Newton, *Opticks*⁴, 399–400.

¹⁰²CUL Add. Ms. 3965, 152^v.

¹⁰³Newton, *Opticks*⁴, 401.

¹⁰⁴CUL Add. Ms. 3970, 619^r [drafts prepared for *Opticks* (1717)].

bodies require divinely governed secondary causes, which serve as the immaterial sources of activity and motion. As we have seen in 3.1, gravity being inherent to matter implies that bodies can act as a source of motion and activity. Newton, however, denied that gravity is inherent to extended regions of impenetrable space that exhibit the usual essential inertial properties and obey the three laws of motion. As Newton wrote in Query 31,

It seems to me farther, that these Particles have not only a *Vis inertiae*, accompanied with such passive Laws of Motion as naturally result from that Force [i.e. the three laws of motion], but also that they are moved by certain active Principles, such as is that of Gravity, and that which causes Fermentation, and the cohesion of Bodies.¹⁰⁵

For Newton robust action at a distance entailed the activity of matter, and the latter is what he explicitly rejected by asserting that “matter is a passive principle & cannot move it self.” In other words, Newton rejected robust action at a distance, because it leads to a theological conclusion that he could not accept: that matter by itself is active and does not depend on God’s secondary causes for its motions. In line with his theological concerns, he saw his gravitational theory as providing room for the active principles, which he conceived of as indications of matter’s dependence on God for its motions.

Given the above context, it is clear that the “elastick” medium, which Newton introduced in Query 21 as a possible explanation for gravity, cannot be other than non-mechanical.¹⁰⁶ Suppose for a moment that the elastic medium that Newton introduced in Query 21 provides a mechanical explanation of gravity, according to which gravity is produced by the direct contact between pieces of matter.¹⁰⁷ If this were the case, then in the Queries Newton would have been involved in a rather surprising inconsistency: on the one hand, he sought to establish that gravity requires a non-mechanical active principle, which is installed and maintained by God, and, on the other hand, he introduced a mechanical explanation of gravity. The gravitational ether that Newton introduced in Query 21 is supposed to “contain Particles which endeavour to recede from one another.”¹⁰⁸ To account for gravity hypothetically, he introduced a gravitational “*Æther*” or “Medium,” which is “much rarer within the dense Bodies of the Sun, Stars, Planets and Comets, than in the empty celestial Spaces between them” and which “in passing from them to great distances,” grows “denser and denser perpetually, and thereby cause the gravity of those great Bodies towards one another, and of their parts towards the Bodies; every Body endeavouring to go from the denser parts of the Medium towards the rare.”¹⁰⁹ At this point, Newton added that “though this Increase of density may at great distances be exceeding slow, yet if the elastic force of this Medium

¹⁰⁵Newton, *Opticks*⁴, 401.

¹⁰⁶Newton, *Opticks*⁴, 350–52. Despite all this, when discussing the Queries, Schliesser contends that “[t]his [i.e. Newton’s discussion of the active principles in nature] allows, as he explicitly says in his Letter to Bentley, that the attractive ‘agent be material.’ If attractive agents can be material then for Newton matter need not always be passive” (Schliesser, “Newton’s Substance Monism,” 163[b]).

¹⁰⁷See n. 50.

¹⁰⁸Newton, *Opticks*⁴, 352.

¹⁰⁹Newton, *Opticks*⁴, 350.

be exceeding great, it may suffice to impel Bodies from the denser parts of the Medium towards the rarer, with all that power which we call Gravity."¹¹⁰ Although the minute particles¹¹¹ of the elastic or, as Newton wrote in corresponding manuscript material, "active"¹¹² ether are indeed material, the inter-particulate repulsive forces between them act non-mechanically. In other words, the medium that he introduced in Query 21 consists of extremely small material bodies that are spatially separated, on the one hand, and the non-mechanical active principle that produces and mediates the repulsive forces between those bodies, on the other. Note that by calling the ether 'active,' he was distinguishing it from a mechanical ether. In Query 28 he argued that a mechanical medium is to be rejected:

And therefore to make way for the regular and lasting Motions of the Planets and Comets, it's necessary to empty the Heavens of all Matter, except perhaps some very thin Vapours, Steams, or Effluvia, arising from the Atmospheres of the Earth, Planets, and Comets, and from such exceedingly rare Æthereal Medium as we described above [i.e. in Query 21]. A dense Fluid can be no use for explaining the Phænomena of Nature, the Motions of the Planets and Comets being better explain'd without it. It serves only to disturb and retard the Motions of those great Bodies, and make the Frame of Nature languish: And in the Pores of Bodies, it serves only to stop the vibrating Motions of their Parts, wherein their Heat and Activity consists. And as it is of no use, and hinders the Operations of Nature, and makes her languish, so there is no evidence for its Existence, and therefore it ought to be rejected.¹¹³

Instead, gravity is to be attributed "to some other Cause than dense Matter" and in the search for the cause of gravity a ban should be put on "feigning Hypotheses for explaining all things mechanically."¹¹⁴ As we have seen above, in Query 31 he was contrasting the passivity of matter with the activity of the immaterial active principles, which included "the cause of Gravity."¹¹⁵ Newton's conviction that "matter is a passive principle & cannot move it self" applies to the material constituents of the ether which he introduced in Query 21 as well. Therefore, the ether does not consist of active matter, rather it consists of material particles that are moved by an active principle.

Given the above context, it seems that the medium which Newton introduced in Query 21 involves non-mechanically mediated action at a distance. His introduction of the ether of Query 21 harmonized perfectly with his endeavor to show that non-mechanical active principles testify of God's providential plan.¹¹⁶

¹¹⁰Newton, *Opticks*⁴, 351.

¹¹¹Newton concluded his discussion of Query 21 by pointing to its explanatory benefits: "The exceeding *smallness* of its Particles may contribute to *the greatness of the force* by which those Particles may recede from one another, and thereby make that Medium exceedingly more rare and elastick than Air, and *by consequence exceedingly less able to resist the motions of Projectiles, and exceedingly more able to press upon gross Bodies, by endeavouring to expand it self*" (Newton, *Opticks*⁴, 352; my italics).

¹¹²CUL Add. Ms. 3970, 261^v and 263^r [drafts prepared for *Opticks* (1717)].

¹¹³Newton, *Opticks*⁴, 368.

¹¹⁴Newton, *Opticks*⁴, 369.

¹¹⁵Newton, *Opticks*⁴, 399.

¹¹⁶Newton, *Opticks*⁴, 400–402. It is clear that Newton was inclined to believe that this ether hypothesis may account for the celestial motions which suffer no sensible resistance. Whether the ether hypothesis introduced in Query 21 may indeed in its technical details account for such motion is another matter, which I shall not further address here.

As we have seen, Newton was convinced that denying active principles was “to speak against Experience.” Why was it so important for Newton to establish God’s providential plan by drawing *upon experience*? The answer is that at the time of the composition of the Queries which appeared in later versions of the *Opticks*/*Optice*, Newton became convinced that “in proving a Deity all a[r]guments ↓not↓ taken from Phænomena are little better then dreams.”¹¹⁷ In similar vein, he wrote as follows:

↓*Even arguments for a Being* [i.e. God] *if not taken from Phænomena are slippery & serve only for ostentation.*↓ An Atheist will allow that there is a Being absolutely perfect, necessarily existing & the author of ~~all-th~~ mankind↓↓ & call it Nature: & if you talk of infinite wisdom ↓or of any perfection more then ↓he allows to say[?]↓ in natur[?]↓ heel ↓recon at a chemæra &↓ tell you that you have the notion of ↓finite or ↓ limited wisdom from what you find in yo^r self & are able ~~without y^e illegible word~~ of your self to ~~add~~ ↓prefix[?]↓ y^e word ↓not↓ & ~~to understand~~ ↓or more yⁿ to any verb or adjective &↓ without the existence of wisdome not limited ↓or wisdome more then finite↓ to understand the meaning of the ~~sentence phrase words~~ phrase as easily as Mathematicians understand ~~the p~~ what is meant by an infinite line or an infinite area.¹¹⁸

Accordingly, in the Queries that were published in later edition of the *Opticks*/*Optice*, Newton set out to demonstrate God’s existence from phenomena.¹¹⁹ This sheds light on Newton’s claim that “if natural Philosophy in all its Parts, by pursuing this Method, shall at length be perfected, the Bounds of Moral Philosophy will be also enlarged. For so far as we can know by natural Philosophy *what is the first Cause, what Power he has over us, and what Benefits we receive from him, so far our Duty towards him, as well as that towards one another, will appear to us by the Light of Nature.*”¹²⁰

Before concluding this section I would like to end with an observation. In Query 28, Newton had emphasized that the philosophers of Greece and Phoenicia tacitly attributed “Gravity to some other Cause than dense Matter,” “↓or mechanism↓,” as he added in corresponding manuscript material.¹²¹ His reference to the ancients in the Queries to the *Opticks* and their corresponding manuscript material¹²² might be taken to imply that, after the composition of the “Classical Scholia,” Newton immersed himself once again in a detailed study of the views of the ancient philosophers. As far as we can tell, however, there is no indication of this whatsoever. In the published versions and in their corresponding manuscript material we do not find a single reference to or quotation from an ancient source. Moreover, there is only one fragment in which Newton mentioned some “celebrated Philosophers” by name:

¹¹⁷CUL Add. Ms. 3970, 622^r [drafts prepared for *Opticks* (1717)].

¹¹⁸CUL Add. Ms. 3970, 619^r; my italics [drafts prepared for *Opticks* (1717)].

¹¹⁹It is useful to contrast Newton’s latter approach in demonstrating the existence of God with his earlier approach, which was based on logical conceivability (e.g. Dobbs, *The Janus Faces of Genius*, 266). Since, as I have already explained, it presently is not my aim to treat the theological portions of the Queries in their own right, I shall refrain from further discussion.

¹²⁰Newton, *Opticks*⁴, 405; my italics.

¹²¹Newton, *Opticks*⁴, 369; CUL Add. Ms. 3970, 246^r [drafts prepared for *Opticks* (1717)].

¹²²CUL Add. Ms. 3970, 246^r–247^r, 249bis^r, 254^v, 270^r, 289^r, 291^r–292^v, and 619^r.

And for rejecting such a Medium we have ↓also↓ the authority of those the oldest & most celebrated Philosophers of Greece & Phenicia, ↓(~~Mochas, Phirecides, Thales, Pythagoras~~)↓ who made a Vacuum, Atoms & the gravity of Atoms the first principles of their philosophy [end of text].¹²³

This suggests that, when he was composing the Queries that appeared in later editions of the *Opticks*, Newton was not embarking in a new series of studies of the ancients sources, but simply reaffirming what he took to be the implications of his earlier studies on the matter.

If the account that I have spelled out above is correct, then, contrary to Janiak and Kochiras, Newton's main concern with robust action at a distance was not that it violated his endorsement of or inclination toward the principle of local action, but rather that it lead to the absurdity of active matter. From the above line of reasoning it is also clear that, contrary to Janiak, Newton did not connect his denial of robust action at a distance with God's ubiquity, but rather with his conviction that robust or Epicurean attraction leads to certain atheistic implications that he was unprepared to accept.

3.3. "... that something in space void of matter"

In this subsection, I would like to elaborate on Newton's usage of 'action at a distance' in the Queries to the *Opticks*. I argue that Newton's usage in the Queries can be explicated by what I have called "non-mechanically mediated action at a distance."

There are a total of 8 occasions in the *Opticks*¹²⁴ and 22 in the draft material of the Queries¹²⁵ in which Newton explicitly referred to action at a distance. The interpretation that I shall defend is explanatory of all 30 aforementioned occurrences. Despite Newton's rejection of what I have called robust action at a distance, in the Queries to the *Opticks* Newton ascribed 'actions at a distance' to a variety of phenomena. *Prima facie* his usage of 'action at a distance' in the Queries seems to suggest that Newton was prepared to accept robust action at a distance to account for various optical processes, as Henry claims, and that in the context of the non-mechanical gravitational ether that he introduced in Query 21, he entertained the possibility of robust action at a distance between its mutually repelling particles, as Henry and Kochiras claim. Can one account for this apparent contradiction? I think one can, because in the Queries to the *Opticks* Newton was talking about non-mechanically mediated action at a distance only.

¹²³CUL Add. Ms. 3970, 289^r [drafts prepared for *Opticks* (1717)]. Newton referred to Thales and Pythagoras in the Classical Scholia (Royal Society Gregory Ms. 247, 6^r–14^v). There he did not, however, mention Mo(s)chus of Sidon or Pherecydes of Syros.

¹²⁴To wit: 1 occurrence in Proposition VIII, Book II, Part III (Newton, *Opticks*⁴, 266); 1 occurrence in Proposition XIV, Book II, Part III (283); 1 occurrence in Query 1 (339); 3 occurrences in Query 29 (371); and 2 occurrence in Query 31 (376 and 395–96).

¹²⁵To wit: 2 occurrences on CUL Add. Ms. 3970, 234^{rv}; 1 occurrence on 241^v; 3 occurrences on 248^r; 1 occurrence on 254^r; 3 occurrences on 257^r; 2 occurrences on 271^r; 1 occurrence on 273^r; 1 occurrence on 281^r; 2 occurrences on 289^r; 1 occurrence on 291^r; 2 occurrences on 292^{rv}; 1 occurrence on 299^r; 1 occurrence on 477^r; and, finally, 1 occurrence on 619^r.

In Query 31, Newton queried as follows: “Have not the small Particles of Bodies certain Powers, Virtues, or Forces, by which they act at a distance . . . ? For it’s well known, that Bodies act one upon another by the Attractions of Gravity, Magnetism, and Electricity; . . .”¹²⁶ Here, it seems that Newton was invoking robust action at a distance. Given his theological observations against Epicurean attraction, which I have brought to the fore in 3.2, it seems very unlikely that he was: postulating robust actions at a distance between the minute particles of the Query 21 ether would entail that the repulsions between those particles are essential to them. Once Newton had launched Query 31, in line with the *scholium* to Section XI of Book I of the *Principia*,¹²⁷ he underscored the following:

How these Attractions may be perform’d, I do not here consider. *What I call Attraction may be perform’d by impulse, or by some other means unknown to me.* I use that Word here to signify only in general any Force by which Bodies tend towards one another, *whatsoever be the Cause.* For we must learn from the Phænomena of Nature what Bodies attract one another, and what are the Laws and Properties of the Attraction, before we enquire the Cause by which the Attraction is perform’d.¹²⁸

In corresponding manuscript material, Newton wrote in a crossed-out fragment: “~~But while I call these forces attraction or repulse, I would not be understood to define the cause or manner of action.~~”¹²⁹ Here, it seems, he was referring to his methodological endeavor to remain neutral with respect to the cause of gravity. His neutrality with respect to the cause entails neutrality with respect to robust action at a distance.¹³⁰ William L. Harper has correctly emphasized that, *in a demonstrative context*, Newton wished to remain neutral with respect to action at a distance: “Newton did not let any philosophical commitment to avoid action at a distance undermine his methodological commitment to make *theory mediated* measurements afford empirical answers to questions about the force of gravity and the masses, interactions and motions among solar bodies.”¹³¹ Accordingly, Harper concludes that, from a methodological perspective, the applications of Law III to distant motion[s] “do not carry any weight to support action at a distance for Newton.”¹³² His methodological endeavor to remain neutral with respect to the cause of gravity, however, *also* entails neutrality with regard to non-mechanically mediated action at a distance and, yet, this is precisely the hypothesis that he entertained in the Queries. While it is definitely correct that he did not introduce a full-blown cause for gravity in the Queries, for he did not stipulate a mode of action for the active principle that produces the repulsive forces of the Query 21 ether, and he admitted that he did “not know what this *Æther* is,”¹³³ he nevertheless speculated that gravity is produced by non-mechanical and divinely mediated active principles—

¹²⁶Newton, *Opticks*⁴, 375–76.

¹²⁷Newton, *The Principia*, 588–89; cf. 408. In the *scholium* to Section XI of the *Principia*, Newton had made it clear that by the word ‘attraction’ he was not defining a mode of action or a physical cause and that ‘attraction’ refers to whatever endeavour of bodies to approach one another.

¹²⁸Newton, *Opticks*⁴, 376; my italics.

¹²⁹CUL Add. Ms. 3970, 254^r, cf. 620^v [drafts prepared for *Opticks* (1717–18)].

¹³⁰Janiak, *Newton as Philosopher*, 35n49.

¹³¹Harper, *Isaac Newton’s Scientific Method*, 367.

¹³²Harper, *Isaac Newton’s Scientific Method*, 368.

¹³³Newton, *Opticks*⁴, 352.

regardless of how these principles ultimately operate. From the Queries, it is in other words clear that *in a speculative context* Newton speculated freely and broke with the methodological neutrality that he endorsed in a demonstrative context. In a speculative context, he rejected, for the theological reasons I have spelled out, robust action at a distance and endorsed non-mechanically mediated action at a distance. Newton, however, carefully separated what he thought could be demonstrated from phenomena and what he thought could not and, accordingly, he did not present his ether speculations as demonstrations, but as queries.¹³⁴

Let us now look at the following statement:

Qu. 17 Is there not *something in* ↓ di ↓ ffused through all space in & through w^{ch} bodies move without resistance & *by means of w^{ch} they act upon one another at a distance* in harmonical proportion of their distances.¹³⁵

I would like to emphasize that this is definitely not at all an isolated occurrence: the drafts to the Queries contain several, nearly identical variants.¹³⁶ On several occasions, Newton phrased variants of the above question in terms of “what is the *means* by which bodies *act upon one another at a distance*?” His way of phrasing this question is important, for it shows that he was dismissive of robust action at a distance and that he was implying that, in order to “act at a distance,” bodies require the mediation of an immaterial substance. In another variant, he wrote, “Can any space be wthout something ↓ in it ↓ & what is that something in space void of matter [& what are its properties & operations ~~on-matter~~]?”¹³⁷ In related manuscript material, he clarified what he understood by a vacuum: “By a Vacuum I do not mean a space void of all substances.”¹³⁸ Correspondingly, although a vacuum is devoid of matter, it contains non-material substances such as active principles, spirits and the like. When drawing attention to the analogy between the optical, magnetic and gravitational “spirits,” he concluded as follows:

Do not all bodies abound with ~~uncertain~~ ↓ a very subtile active vibrating ↓ spirit by w^{ch} light is emitted reflected & refracted, electric & magnetic attractions ↓ & fugations ↓ are performed, the ~~contiguous~~ ↓ small ↓ particles of bodies cohære when contiguous, & agitate ~~illegible word~~ one another at ↓ small ↓ distances & regulate ↓ almost ↓ all their motions amongst themselves as the great bodies of the Universe regulate theirs by the power of gravity? *For electric bodies could not act at a distance without a spirit reaching to that distance.*¹³⁹

The implications of the above draft material are that Newton was indeed endorsing the view that “action at a distance” is mediated by non-mechanical agents. What the above and related manuscript material shows is that in the Queries he used ‘action at a distance’ to refer to what I have called “non-mechanically mediated action at a distance.” His usage of ‘action at a distance’ in the Queries did not at all commit himself to robust action at a distance. Instead, he emphasized that “action

¹³⁴Cf. Ducheyne, “The main Business of Natural Philosophy,” 283.

¹³⁵CUL Add. Ms. 3970, 234^r; my italics [drafts prepared for *Opticks* (1717)].

¹³⁶These are to be found on CUL Add. Ms. 3970, 261^r, and 291^r [drafts prepared for *Opticks* (1717)].

¹³⁷CUL Add. Ms. 3970, 291^r.

¹³⁸CUL Add. Ms. 3970, 621^r [drafts prepared for *Opticks* (1717)].

¹³⁹CUL Add. Ms. 3970, 241^r; my italics [drafts prepared for *Opticks* (1717)].

at a distance" is produced by a non-mechanical secondary cause that mediates between gravitationally interacting bodies. To take Newton's usage of 'action at distance' in the *Queries* in a robust sense is to disregard his theological concern that, by admitting robust action at a distance, gravity would be essential to matter and it is to neglect also his intention to provide room for divinely mediated "active principles" within the realm of nature.

By now I have argued that one should distinguish between two different senses of 'action at a distance.' Moreover, I have argued that both senses can clearly be found in Newton's work and that by distinguishing between them one can account for all *prima facie* conflicting fragments in Newton's *corpus*. Put differently, I have argued that the distinction between robust and non-mechanically mediated action at a distance is explanatory of Newton's usage of 'action at a distance.'

4. CONCLUSION

In this paper I have argued that Newton, when discussing action at a distance, used 'action at a distance' in two distinct senses: while in his fourth letter to Bentley Newton was rejecting robust action at a distance, in the *Queries* he was using 'action at a distance' to refer to non-mechanically mediated action at a distance, which was compatible with his desire to point to the theological significance of certain non-mechanical active principles. I have also explicated Newton's understanding of the claim that gravity is essential to matter and argued that Newton's rejection of robust action at a distance cannot be separated from his rejection of Epicurean attraction. Furthermore, I have clarified that he rejected robust action at a distance because of its theologically unacceptable implications: that matter is active and requires no divinely mediated secondary causes for its motions. Finally, I have shown that, although Newton did not stipulate a *modus operandi* for the inter-particle repulsive forces of the Query 21 ether, he broke with the methodological principle of neutrality with respect to the cause of gravity, which he consistently put to practice in a demonstrative context, by invoking the hypothesis of non-mechanically mediated action at a distance.

Kochiras has correctly noted that Newton ran into the fundamental problem of showing how his preferred non-mechanical medium could be established by empirical means.¹⁴⁰ The non-mechanical ether, which Newton introduced in Query 21, is indeed beset with insurmountable methodological problems. The relevant question is, however: should we, *in order to understand what Newton was doing in the Queries to the Opticks*, judge the contents of the *Queries* by those criteria that he considered to be crucial in the demonstrative part of natural philosophy? In my view, we should not, for it is clear that the speculative nature of the *Queries* was patently different from the demonstrative ethos of the *Principia*. Since in the *Queries* Newton was speculating instead of demonstrating, it should not come as much of a surprise that he did not live up to the methodological standards that he endorsed when demonstrating.

¹⁴⁰Kochiras, "Gravity and Newton's Substance Counting Problem," 277[b]–79[a].

Moreover, by judging Newton's Queries only from a methodological perspective, we might fail to see what he conceived of as being the *raison d'être* of Queries 21 and 31. In the introduction I have emphasized that from the 1706 edition of *Optice* and onwards the Queries or *Quaestiones* not only served Newton's endeavour to stimulate future research, but that, at the same time, they began to serve his theological agenda as well. It was in his 1706 *Optice* that Newton launched the theological ethos that would become characteristic of his 1713 General Scholium, as Stephen D. Snobelen has aptly reminded us.¹⁴¹ Although from a methodological perspective Query 21, which was introduced in the 1717 edition of the *Opticks*, was surely vexed by methodological problems, Newton found it important enough to make it public. Why did he hazard this methodologically precarious hypothesis? Was it to stimulate future inquiry—although he was clearly aware that it would be extremely difficult to demonstrate the veracity of his hypothesis? Or could it be that Newton was convinced that Query 21 was important enough to make public for different reasons? The answers to these questions can be found in the already mentioned advertisement to the 1717 edition of the *Opticks*. There Newton declared, “*At the End of the Third Book I have added some Questions. And to shew that I do not take Gravity for an essential Property of Bodies, I have added one Question concerning its Cause, chusing to propose it by way of a Question, because I am not yet satisfied about it for want of Experiments.*”¹⁴² From its context it is clear that Newton was referring here to Query 21. In the above advertisement, Newton was explicit about why Query 21 was so important to him: because he wanted to show that he did not take gravity for an essential property of bodies. In my opinion, showing that gravity is not essential to matter and that it requires non-mechanical active principles, which are governed by God, was for Newton such “a duty of the highest moment”¹⁴³—especially in view of his growing belief that arguments for the existence of God should be drawn from phenomena—that he was prepared to set aside his highly sophisticated methodological standards and to indulge in revealing aspects of his theological agenda.

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¹⁴¹Snobelen, “The Theology of Isaac Newton's *Principia mathematica*.”

¹⁴²Newton, *Opticks*⁴, cxxiii.

¹⁴³National Library of Israel, Yahuda Ms. 1.1, 3^r.

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